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ABSTRACT

This document presents an educational research study conducted with 20 pre-service secondary science teachers to assess the effects of training in the systematic analysis of science processes on their use of strategies for teaching data collecting, processing, and interpreting. The results indicate that teaching behavior can be influenced when subjects are provided with an observation system which allows them to examine the operations and interactions which constitute a lesson. (SL)

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THE EFFECTS OF PROCESS SKILL ANALYSIS ON THE TEACHING OF DATA COLLECTING, PROCESSING AND INTERPRETING

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THE EFFECTS OF PROCESS SKILL ANALYSIS
ON THE TEACHING OF DATA COLLECTING,
PROCESSING AND INTERPRETING

The processes of sciences are central to the domain of science and are one of the factors which distinguish it from other human endeavors. They should play the same central role in science teaching. Science educators at all levels claim that science is more than a body of knowledge. The cognitive processes of science have been identified and the process approach is advocated as a means to involve students in the scientific interprise. Yet, teacher trainers find it difficult to induce teachers to use a science process oriented approach. The reasons for this may be: (1) the poor definition of the processes, and (2) a lack of well articulated descriptions of teacher and pupil activities which occur as the process skills are being taught and learned. In an effort to address the above problem, Yeany and Capie (1977) developed the Data Processing Observation Guide (DPOG). Their focus on data processing (collection, manipulation and interpretation) is based on the frequent use of these processes to define "science" and "sciencing" (e.g., Science-A Process Approach, 1967, 1974, 1975).

The DPOG describes and measures the occurence of ten specific operations and three general interactions which occur in a classroom where science process skill learning is taking place (see Figure 1).

The DPOG has two functions. First, it can be employed as a science teacher training tool where the trainer engages the teacher in systematic analysis of models (e.g., video tapes) of data processing behaviors. Potentially, this analysis can assist the teacher in identifying, communicating and designing data processing learning activities. The second

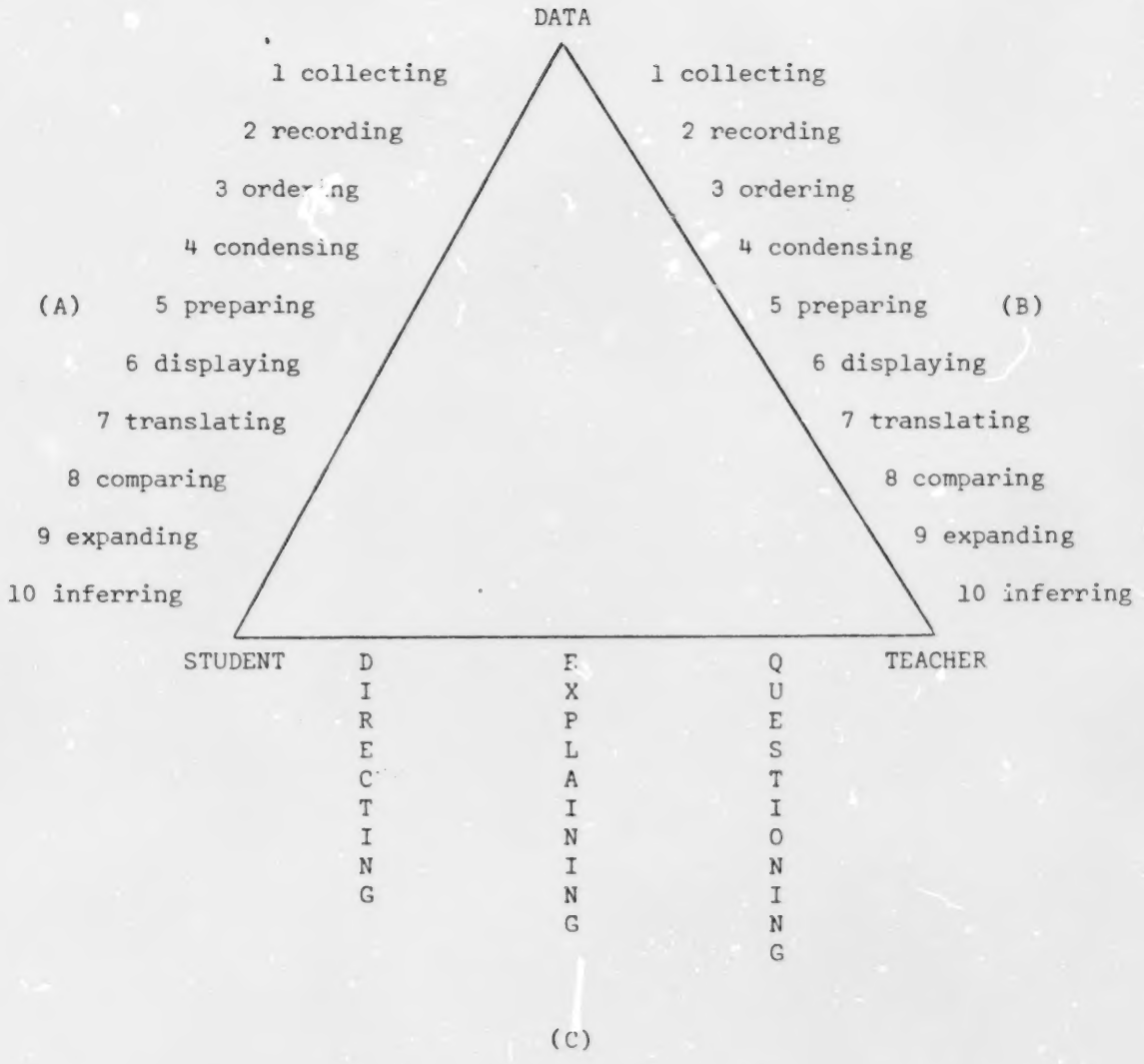

Figure 1. A model of operations and interactions that occur when students and teachers are working with data.

function is to assess classroom behavior. In this function the DPOG serves as an assessment tool for research and program evaluation.

When using the DPOG, the operations and interactions are recorded at pre-selected intervals in the appropriate rows and columns of the tally sheet shown as Figure 2. After classroom behaviors have been recorded, several sets of indices which summarize the nature of the data processing lesson can be computed. The most simple indices are the frequency counts wich are recorded at the bottom of the DPOG. They record the number of occurrences of each type of operation or interaction. The frequency/time ratios indicate the portion of time devoted to student activity (A), teacher demonstration (B), or teacher attempts to influence student data processing (C). The frequency/frequency ratios provide an indication of how much activity occurred in the lesson (see Figure 2).

The purpose of the present study was to assess the effects of training teachers in systematic analysis of science process teaching on their selection of strategies for teaching data collecting, processing and interpreting.

PROCEDURES

Subjects

All subjects in the study were pre-service secondary teachers enrolled in the undergraduate science teacher preparation program at the University of Georgia. These students had completed their science content, foundations of education, and educational psychology courses as well as the basic arts and sciences curriculum core. Most would complete both graduation and teaching certification requirements with the completion of the two quarter sequence in science teacher training. None of

Data Processing Observation Guide*

INTERVAL	D	A	B	C	
		OPERATION	OPERATION	INTERACTION	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
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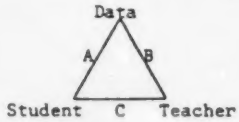

elapsed time _____

fA/time _____
fB/time _____
fC/time _____

$\frac{fA}{fB} =$ _____

$\frac{fA}{fA + fB + fC} =$ _____

$\frac{fA + fB}{fA + fB + fC} =$ _____

fA_1 _____	fB_1 _____	fC1 _____	fCd _____
fA_2 _____	fB_2 _____	fC2 _____	fCe _____
fA_3 _____	fB_3 _____	fC3 _____	fCq _____
fA_4 _____	fB_4 _____	fC4 _____	
fA_5 _____	fB_5 _____	fC5 _____	
fA_6 _____	fB_6 _____	fC6 _____	
fA_7 _____	fB_7 _____	fC7 _____	fO _____
fA_8 _____	fB_8 _____	fC8 _____	
fA_9 _____	fB_9 _____	fC9 _____	
fA_{10} _____	fB_{10} _____	fC10 _____	

Figure 2

*From Yeany and Capie (1977)

the subjects had any formal teaching experience. But, all were observing and assisting in a public school science class for four hours each week.

Prior to treatment all subjects demonstrated proficiency in the process skills during self-paced instructional activities.

Treatment Levels

In order to address the research question in this study twenty subjects were randomly assigned to one of the following treatments.

LEVEL I (Experimental)

> All subjects in this group were trained to use the DPOG to determine the type and frequency of data operations occurring in a classroom (e.g., collecting, ordering, and communicating) and who performs each (i.e., student or teacher). After becoming familiar with the guide through discussions and applications to model teaching sequences, these subjects were assigned to design and peer-teach a video-taped lesson which involved data collection, manipulation, and interpretation. Subjects then used the observation guide to complete a systematic self-analysis of their teaching behavior during a private viewing of their tapes. A second process skill lesson was then taught and also video-taped.

LEVEL II (Comparison)

> All subjects in this group received no special instruction in the analysis of process skill teaching strategies. As in Level I, they were assigned to teach a lesson involving data collection, manipulation, and interpretation to their peers. After this, they scheduled a private unstructured viewing before teaching a second video-taped lesson involving the same skills.

Dependent Variables

Data on the dependent variables were collected by trained observers who used the Data Processing Observation Guide to measure teacher/student behavior. As mentioned earlier, the DPOG can be used to determine the frequency of ten different data processing operations (e.g., collecting, ordering, expanding, and displaying) and teacher-student interactions in a science classroom. Several indices of the relative occurrence of data

processing operations involving both students and teachers can be generated with the instrument. Six of these indices were selected as the dependent variables of interest in this study. They were:

fA/time: Occurrence Rate of Student Data Operations;

fB/time: Occurrence Rate of Teacher Data Operations;

fC/time: Occurrence Rate of Teacher/Student Interactions regarding Data Manipulations;

fA/fB: Ratio of Student Data Operations to Teacher Data Operations;

fA/fA + fB + fC: Ratio of Student Data Operation to Total Operations and Interactions;

$\frac{fA + fB}{fA + fB + fC}$: Ratio of Data Operations to Total Occurrence of Data Operations and Interactions.

Analysis of variance procedures were used to identify significant differences in index means which could be attributed to treatment efforts. Dependent sample analysis was used to assess shirts from the first taped lesson to the second.

RESULTS

The means on each process skill teaching index for each treatment group and each lesson are given in Table 1.

TABLE 1

Means of Process Skill Teaching Indices on First and Second Lesson

	Group			
	Experimental		Comparison	
Index	Lesson #1	Lesson #2	Lesson #1	Lesson #2
fA/T	1.66	1.79	.75	.65
fB/T	.34	.18	.57	.44
fC/T	.59	.59	.69	.39
fA/fB	9.23	10.30	1.62	.84
fA/fA + fB + fC	.64	.69	.34	.39
fA + fB/fA + fB + fC	.77	.75	.61	.66

The data analysis indicated that the process skill teaching behavior of the subjects was significantly influenced by the initial treatment involving training in the use of the structured analysis system on three of the six indices (p = .003, .03 and .005) (see Table 2).

TABLE 2

Analysis of Variance Summary Table on the Process Skill Teaching in the First Lesson

Index	F Ratio	p
fA/T	12.87	.003
fB/T	1.52	.23
fC/T	.23	.64
fA/fB	5.07	.04
fA/fA + fB + fC	10.41	.005
fA + fB/fA + fB + fC	2.36	.14

These results indicated that, on the first lesson, the experimental subjects received higher values on all indices which measured the level of pupil involvement in data operations. The experimental subjects' second lessons also continued to be more pupil oriented when compared to the comparison group as indicated by significant differences on the same indices (p = .04, .005 and .001) (see Table 3). No other significant differences occurred.

TABLE 3

Analysis of Variance Summary Table on the Process Skill Teaching in the Second Lesson

Index	F Ratio	p
fA/T	10.73	.005
fB/T	2.29	.15
fC/T	1.50	.24
fA/fB	17.17	.001
fA/fA + fB + fC	4.73	.04
fA + fB/fA + fB + fC	.66	.43

A dependent sample analysis for changes in teaching behavior from the first lesson to the second indicated that there were no significant changes within either group which could be attributed to tape viewing procedures. The initial changes in teaching behavior due to training in strategy analysis were persistent but no further changes resulted from viewing the first tape (see Table 4). Table 4 also provides the reliabilities of the average ratings of two judges on each index as estimated by Hoyt procedures.

DISCUSSION

The results indicate that process skill teaching behavior can be influenced when subjects are provided with an observation system that allows them to examine the operations and interactions which constitute a lesson. After analysis, teaching is characterized by greater pupil involvement in the lesson. Also, these changes are persistent to a second taped lesson. This persistance may be due to self analysis of

TABLE 4

Analyses of Changes in Process Skill Teaching Behavior
From the First to Second Lesson

Index	Reliability	Treatment	Change	t	p
fA/T	.78	EXP	-.13	.68	.52
		CON	.09	.38	.72
fB/T	.95	EXP	.16	1.59	.15
		CON	.13	.48	.64
fC/T	.91	EXP	.01	.05	.95
		CON	.31	1.89	.10
fA + fB	.57	EXP	-1.06	.25	.81
		CON	.78	1.37	.21
fA/fA + fB + fC	.99	EXP	- .05	.59	.57
		CON	- .05	.36	.73
fA + fB/fA + fB + fC	.97	EXP	.02	.24	.81
		CON	- .04	.36	.73

the first tape or residual effect from initial training in the analysis system. Additional research is needed to establish the influence of initial training without self analysis. This treatment alone may be powerful enough to cause desireable shifts in teaching behavior.

The need to offer a more balanced approach to science teaching by including training in the cognitive processes of science has been argued for several decades. Curriculum developers on the national and local levels have been both involved in and influenced by the debate. Most science curricula now include objectives related to pupil acquisition of skills such as data collection, manipulation and interpretation. And, many science teachers possess the data processing skills described, yet have difficulty in applying them in teaching. The implimentation of process skill observation, as described in this study, as a teacher training activity may overcome some of this difficulty.

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